Summary Report of Geologic Resources Evaluation Workshop (September 2002)
And Status of On-going Mapping (January 2006)
North Cascades NP, Ross Lake NRA, and Lake Chelan NRA

Introduction

A Geologic Resources Evaluation (GRE, formerly Geologic Resource Inventory) workshop for parks in the North Coast and Cascades Network was held in Seattle, Washington on September 10th through 12th, 2002. The purpose of the workshop was to discuss the status of geologic mapping in the parks and the associated bibliographies for compiling both paper and digital maps, and to identify sources of available information and geologic resource management issues and needs. The workshop involved a 4 to 8 hour scoping session for each park during which overviews of the NPS Inventory and Monitoring (I&M) program, the role of WASO-Geologic Resources Division (GRD) in overseeing the baseline inventory for geologic resources, and the on-going service-wide GRE were presented. The actions and products derived for each park from this workshop include: (1) review and discuss geologic maps in the published record and current mapping in progress to determine which geologic maps will comprise the parks' baseline inventories and be digitized into a GIS; (2) identify any new geologic mapping needs; (3) update and verify the bibliographies; (4) write a summary report of the workshop; and (5) write a Geologic Resources Evaluation Report which brings together all of these products. This document is the summary report of the workshop and status of on-going mapping for North Cascades National Park and Ross Lake and Lake Chelan National Recreation Areas (NOCA).

Cooperators from the NPS Geologic Resources Division (GRD), NOCA, the Pacific West Regional Office, Washington State DNR - Department of Geology and Earth Resources (DGER), and Colorado State University were present for the workshop.

Overview of the Geologic Resources Evaluation

The NPS Geologic Resources Evaluation (changed from Geologic Resources Inventory in July 2003) is a cooperative endeavor to implement a systematic, comprehensive inventory of the geologic resources in units of the National Park Service. It is one of twelve baseline inventories of the NPS Inventory and Monitoring Program. For the 273 park units with significant natural resources, the GRE consists of four main activities and associated products:

1. **Compile a bibliography of geologic literature and maps.** Assemble a bibliography ("GRBIB") of known geological publications and compile and evaluate a list of existing geologic maps for each park,

    Geologic bibliographies are a subset of NPS "NRBIB" and are an attempt to locate all known park geologic references. These references are incorporated into the GRBIB website and distributed as Microsoft Access databases. Presently, the GRBIB data are being migrated into NRBIB by the NPS Office of Inventory and Monitoring.

2. **Conduct an on-site workshop to evaluate park geologic maps, resources and issues and write a summary report (this document) for each park.**

    Workshops are held at parks to inventory and review available data on park geology and to discuss geologic issues. These workshops bring together park resource managers with geologists who are familiar with the park's geology who may come from the USGS, state, local or academic institutions. Weather permitting, there is usually a one-day fieldtrip, with a subsequent round-table discussion on the availability and quality of existing geologic information, including geologic maps, and park specific geologic resource issues and management, interpretive, and research needs.

3. **Develop digital geologic GIS data products with accompanying supporting information.**

   Digitizing geologic maps facilitates the incorporation of geologic considerations into a wide range of applications. The purpose of the GRE digital geologic mapping effort is to:

   - Reveal existing known geologic map extent and scale;
   - Acquire and evaluate known maps for usefulness of scale, quality and extent;
   - Initiate digitizing of acceptable existing geologic maps and/or seek new field mapping projects to fill gaps in the map record;
   - Attribute digital data per the NPS digital geologic model for service-wide digital standards and protocols.

4. **Write a Geologic Resources Evaluation Report with basic information on geologic setting and history, geologic hazards, and other geologic related issues.**

   Park-specific geologic reports identify geologic features and processes that are important to park ecosystems and resource management, the impact human activities have on geologic features and processes, geologic research and monitoring needs, and opportunities for education and interpretation. In addition, geologic reports provide a brief geologic history of the park and address specific geologic formation properties, thus providing a critical link between the geologic map and the resource manager.

The emphasis of the inventory is not to routinely initiate new geologic mapping projects, but to aggregate existing "baseline" information and identify where serious geologic data needs and issues exist in the National Park System. In cases where map coverage is nearly complete (e.g. 4 of 5 quadrangles for Park "X"), or maps simply do not exist, then funding may be available for mapping the park's geology.

During the workshop Bruce Heise (NPS-GRD) presented overviews of the Geologic Resources Division, the NPS I&M Program, the status of the Natural Resource Inventories, and the Geologic Resource Inventory in particular. Joe Gregson (NPS-NRID) presented a demonstration of some of the main features and utility of a digital geologic database using the Black Canyon of the Gunnison NP (BLCA) and Curecanti NRA (CURE) in Colorado as an example. BLCA/CURE has become the prototype for the NPS digital geologic map model as it reproduces all aspects of a paper geologic map, including map notes, cross sections, lithologic columns and legend, with the added benefit of being geospatially referenced. It is displayed in ESRI ArcView shape files and features a built-in Microsoft Windows help file system to identify the map units. It can also display scanned JPG or GIF images of the geologic cross sections supplied with the paper "analog" map. Geologic cross section lines (e.g. A-A') are subsequently digitized as a line coverage and are hyperlinked to the scanned images.

GRBIB

During the workshop, individual Microsoft Word documents of Geologic Bibliographies for NOCA were distributed. The sources for this complied information are as follows:

- AGI (American Geological Institute) GeoRef
- USGS GeoIndex
- ProCite information taken from specific NPS park libraries

These bibliographic compilations were validated by GRE staff to eliminate duplicate citations, typographical errors, and to check for applicability to the specific park. After validation, they become part of a Microsoft Access database parsed into columns based on park, author, year of publication, title, publisher, publication number, and a miscellaneous column for notes.

For the Access database, they are exported as Microsoft Word documents for easier readability, and eventually turned into PDF documents. These data are planned to be migrated into the NPS servicewide bibliographic website late in 2006 where they can be found at http://science.nature.nps.gov.im.

Quadrangles of Interest

There are 105 7 ½-minute quadrangles of interest (QOI) for NOCA (appendix A). These quads were identified by the park in the early 1990s for base cartography inventory and initially adopted by the geologic resource evaluation for query in identifying and obtaining baseline geologic information. Park QOIs typically include a one-to-three quad information buffer around the park. But there is no identified buffer along the north boundary of NOCA; this is the 49th parallel bordering Canada. The park would like to include geologic map data from Canada, extending northward to $49^{o}30'$ or 50^{o}, in the park's geologic baseline inventory. Topographic and landform connectivity that transcends the border influences geologic, hydrologic, and meteorological processes in the park that require park managers to regularly interact with Canadians on environmental and energy commissions.

Review of Published Geologic Maps

Using the GRBIB bibliography for NOCA, a search and reference list was made for any existing surficial and bedrock geologic maps covering the quads of interest (appendix B). From this search several index maps were created and distributed during the meeting that show the spatial layout of geologic map coverage at various scales for the park. These scales range from 1:250,000 down to 1: 2,000, and provide partial to complete coverage of the park. Also, the Washington DGER has an on-line geologic map index of their publications that includes a searchable bibliography. This database is available at http://www.dnr.wa.gov/geology/washbib.htm. Washington DGER also has the entire state's bedrock geology mapped at 1:100,000 and 1:250,000 scales, some of which was compiled from previous work done by the USGS. These maps are also available in digital form.

Maps smaller than 1:100,000-scale were not individually discussed during the meeting since this scale of mapping generally does not provide the level of detail and site specific information necessary to meet the "knowledge of resources" purposes of the GRE. Selected maps should be the largest scale appropriate to the subject, thereby having the highest spatial fidelity. The preferred map scale for the GRE is 1:24,000 (7 ½-minute quadrangles). But, these are not always available for complete coverage of a park. For larger parks, geology mapped on 15-minute quadrangles may be the preferred scale to meet the needs of the geologic baseline inventory.

Some meeting participants had direct or indirect knowledge about some of the larger scale geologic maps which aided our discussion in determining the appropriate maps, if any, to comprise the baseline geologic map inventory and coverage for the park.

Bedrock geology mapping

Roland Tabor, USGS, has mapped the general geology of the North Cascades Range from the mid-1970s through 1995. His field mapping was done at a scale of 1:24,000, with subsequent compilation of the data onto eight 1:100,000 scale (30 x 60 minute) quadrangles. Six of these quads are published as USGS-I maps and the remaining two are completed and awaiting publication. The six published maps are Chelan, Wenatchee, Skykomish River, Snoqualmie Pass, Sauk River, and Mt. Baker. They are available in both printed and digital form (Arc Info). Ralph Haugerud, USGS, assisted with the mapping of Mt. Baker and the final two maps, Robinson Mountain and Twisp, and anticipates that the latter two will be published by the mid-2000s. These two maps will show significantly updated geology from the existing Washington DGER data.

The Washington DGER has six 100K maps covering the North Cascades area that were published in the 1980s and 1990s. Their 250K-scale map is considered to be more updated than their 100K maps, which were primarily reconnaissance. But, since the 100K maps are used more than the 250K maps, the state may re-work and update their 100K maps. The state has already translated the symbology for six of the maps. The Robinson Mountain 100K quad is substantially different between the USGS and Washington DGER maps. Presently, the state is focusing their mapping on hazard-related issues in high population areas, as well as where aquifers are of interest.

The geology of the park is very complex and difficult to figure out; requiring a geologic mapper with a lot of petrologic skill. Ralph Haugerud doesn't know how anyone can improve on the quality of the mapping that was done by Roland Tabor. Tabor's maps have already proven very useful to the park with which he shared the data prior to publication.

Participants at this meeting agreed that bedrock map coverage and associated reports are currently adequate for NPS units in Washington, and that future work should focus on acquiring surficial geology inventories. For reasons provided above the USGS 1:100,000 scale geologic maps by Roland Tabor (and others), rather than the maps by Washington DGER, were determined to best meet the bedrock geology data needs for the NPS Baseline Inventory for NOCA. Four of Tabor's eight maps discussed above provide coverage of the park and the two adjacent recreation areas. These maps are:

(1) Tabor, R. W.; Haugerud, R. A.; Hildreth, W.; Brown, E. H., 2003,
Geologic map of the Mount Baker 30- by 60- minute quadrangle, Washington,
USGS I-Map 2660, 1:100,000 scale.
http://pubs.er.usgs.gov/pubs/i/i2660

(2) Tabor, R. W.; Booth, D. B.; Vance, J. A.; Ford, A. B., 2002,
Geologic map of the Sauk River 30- by 60-minute quadrangle, Washington,
USGS I-Map 2592, 1:100,000 scale.
http://pubs.er.usgs.gov/pubs/i/i2592

(3) Tabor, R. W., et al., (in press)
Geologic map of the Robinson Mountain 30- by 60-minute quadrangle, Washington,
USGS I-Map XXXX, 1:100,000 scale.

(4) Tabor, R. W., et al., (in press)
Geologic map of the Twisp 30- by 60-minute quadrangle, Washington,
USGS I-Map XXXX, 1:100,000 scale.

Glacier Monitoring
North Cascades National Park has an active glacier monitoring program that also provides assistance with monitoring glaciers on Mount Rainier. Base map information for North Cascades NP includes a 1971 study/inventory of glaciers at 1:24,000. Monitored glaciers were mapped at 1:2000 scale in 1993 and 2002. Glacial extent in the park has recently been remapped at 1:12,000 by Frank Granshaw of Portland State University using color aerial photos. This map is now in use in the park's GIS.

Geologic Research Activities and Needs

Landform Mapping - A Twist on Surficial Geologic Mapping
Geologists at North Cascades have been mapping surficial geology since the late 1980's in support of various resource management programs and in the absence of soils or surficial data. Since 1997, the park has used a hierarchical mapping scheme that focuses at two scales and is linked to the USFS Ecological Unit Inventory (ECOMAP, 1993). This is a little different than standard surficial geologic mapping, since it is designed to support the park's long-term ecological monitoring program. This type of mapping readily identifies scale and spatial distribution of geological disturbances which can then be analyzed in relationship with other ecological processes and features. Landform maps are also more readily interpreted by resource professionals in other disciplines.

Landtype associations, mapped at a scale of 1:62,000 (1 inch = 1 mile), are broad scale, primarily erosional landform features such as U-shaped valleys, valley floors and glacial cirques. This scale of mapping is accomplished by stereoscopic interpretation of aerial photos. At the time of this meeting about half of the park has been mapped at this scale, with 75% of the features classified as valley wall or cirque.

Landforms are smaller landscape units that are nested into the landtype associations. Therefore mapping landforms is done at a larger scale, 1:24,000, and requires field work to identify features that are not discernable on aerial photos due to their size or concealment by vegetative cover. Twenty-eight types of smaller, primarily depositional landforms such as terraces, alluvial fans, floodplains and mass movements have been identified at North Cascades NP. This scale of mapping also includes a landslide inventory ranging from rock falls to large debris slides. At the time of the meeting about 30% of the park had been mapped at this scale, with only 2% of the park classified as valley bottom – where most of the human activity occurs. At the time of this writing - January 2006 – landform mapping for 75% of the park and encompassing five large watersheds, Thunder Creek, Chilliwack Creek, Stehekin River, Bacon Creek and Baker Creek, have been completed and digitized.

The utility and cost effectiveness of these maps has led other resource managers in the North Coast and Cascades Network (NCCN) and other NPS program managers to request similar surficial map coverage. For instance, landtype association scale mapping is completed and digitized for Mount Rainier. Many of the units are large erosional features. An overall cost for landform mapping averages out to $0.30 per acre.

Geologic Resource-Related Management Issues and Needs

Landform mapping

The on-going landform mapping supports the park's ecological long-term monitoring with demonstrated applications to identifying and tracking geological disturbances, fire history, and cultural resource sites. Analysis of geologic and landform maps provide information and understanding on vegetation patterns and paleo-ecology, hydrological response of watersheds, derivative maps for fire regimes, geologic hazards, information for cultural resource surveys, and natural history information for interpreters.

Soil mapping

Researchers at Washington State University are mapping soils in the park as part of a study to develop a new approach for mapping soils in wilderness. Information on soil types and distribution is needed in a GIS in conjunction with vegetation, geologic and hydrologic information for long-term ecological monitoring.

Rivers

Hydrologic modeling of Lake Chelan shows a back water effect extending about 0.5 mile up the Stehekin River at the head of the lake. The impact on sedimentation is not known, but over the years segments of the lower part of the river are being channelized and hardened.

Reservoirs

After spring snowmelt there is a six-week period when the reservoir is drawn down. Exposed lake beds during this time leads to major dust storms.

Public Use Corridors

Park development activities along the Thunder Lake fault at Sourdough Creek de-stabilizes the base of a slope leading to a recurrence of rock avalanches. Road maintenance activities by Washington DOT activities along Highway 20 yields similar slope instability issues with subsequent rock falls onto the travel corridor.

AML sites
The state of Washington Department of Geology and Earth Resources (DGER) regulates all surface mining activities in the state. While Washington has some mining history, it is not as extensive as in most other western states. In the late 1990's the state started an abandoned mine lands (AML) program to map these sites and mitigate public safety and resource protection. But, the state has not looked at AML sites in national parks. AML sites are known to exist in the North Cascades, but they have not been mapped at the time of this meeting for their biological, cultural and hazards significance. The park is concerned that these sites may be contributing to adverse water quality, an effect that can extend beyond the confines of the AML sites. The Holden mine, located west of Lake Chelan near its north end, is a superfund site on adjacent USFS land.

2006 Update

Bedrock Geology Mapping
Much of Roland Tabor's and Ralph Haugerud's careers with the USGS have been spent mapping the geology of the North Cascades of Washington at a scale of 1:24,000. This achievement establishes an unsurpassed standard of geologic knowledge of the Cascade Crest from Snoqualmie Pass to the Canadian border. Tabor and Haugerud have recently compiled this information onto one map at 1:250,000 scale. This map will be published by the USGS and includes the geologic information from the Mount Baker, Sauk River, Robinson Mountain, Twisp, Skykomish River, Chelan, Wenatchee and Snoqualmie Pass 1:100,000 scale maps mentioned earlier in this report. The Robinson Mountain and Twisp 1:100,000 scale maps are in press and, along with the Mount Baker and Sauk River published maps, meet the park's baseline inventory needs for bedrock geologic data.

Landform Mapping
The landform mapping program was supported in FY03 through FY05 by four primary sources of funds: Geologic Resource Evaluation (GRE) - Soils Inventory ($100K), GRE Surficial Geology Inventory ($60K), NCCN Inventory and Monitoring funds ($52K) and NOCA base funds ($60K). Progress on several projects was made using these resources, as summarized below.

At NOCA, funds have supported completion of landform scale mapping at 1:24,000 scale for approximately 75% of the park between 2003 and 2005, including the Bacon, Baker, Stehekin, Big Beaver and Little Beaver watersheds. Mapping was also initiated in Goodell and Newhalem creeks with completion of the park scheduled for 2007. Results from various watersheds have been presented to geologists and other resource managers for review at several conferences and meetings, including the George Wright Society, West by Northwest, Soil Society of America, and the Geological Society of America Annual meeting in Seattle (1994). Results for five watersheds covering 555 square miles were also published in the fall 2005 issue of Park Science. Supporting information including a summary of landform distribution, geologic disturbance, and geologic history by watershed are in preparation.

At MORA, funds supported acquisition of landform maps for 30% of the park. Watersheds completed include Tahoma Creek, Nisqually River, Cowlitz River and Ohanepecosh River. Crews also began mapping White River in 2005, and the park is scheduled for completion in 2009.

At OLYM, funds were used to map the landforms of the Elwha Valley. Timely completion of this data is supporting efforts to plan for restoration of the valley after removal of the upper Elwha Dam. Our data have been linked with soils and vegetation and are providing baseline information on the natural history and habitat of this valley.

Draft landform maps have also been completed for EBLA and SAJH units of the NPS. At EBLA landforms were mapped using LiDAR data, which provides stunning views of landscapes and was provided by the Puget Sound Lidar Consortium. Lidar data acquired by the consortium in 2005 will be used to make final changes to the landform map for San Juan NHP.

Table 1. Schedule of landform mapping at parks in the North Coast and Cascades Network.

NCCN Park	EBLA	SAJH	**NOCA**	MORA	OLYM
Scheduled completion	2007	2007	**2007**	2009	2011
Amount completed as of January 2006	90%	90%	**75%**	30%	10%

Soils Mapping
NOCA staff participated in a soil scoping meeting for the North Coast and Cascades Network in Mt. Vernon, Washington in FY03. This meeting brought together professionals from USGS, NRCS, NPS, area Universities and state and local government agencies to develop a program for mapping soils at the three large NPS areas in Washington. A separate report contains the summary of this meeting.

Since that time over the past three years landform maps have provided crucial baseline information for development of a RASP (remote area soil proxy) soil model for the remote, 116 square mile Thunder Creek watershed at NOCA in a cooperative effort between the NPS (Biggam), NOCA (Riedel), NRCS and Washington State University (Dr. Busacca). Landforms provided information on landscape age, parent material, topography and stability that makes accurate RASP models possible. Thus, landform mapping data has paved the way for acquisition of soils data for all of the remote wilderness lands in Washington's National Parks.

References

Tabor, Roland and Ralph Haugerud, Geology of the North Cascades: A Mountain Mosaic; 1999, The Mountaineers

Scoping Meeting Participants

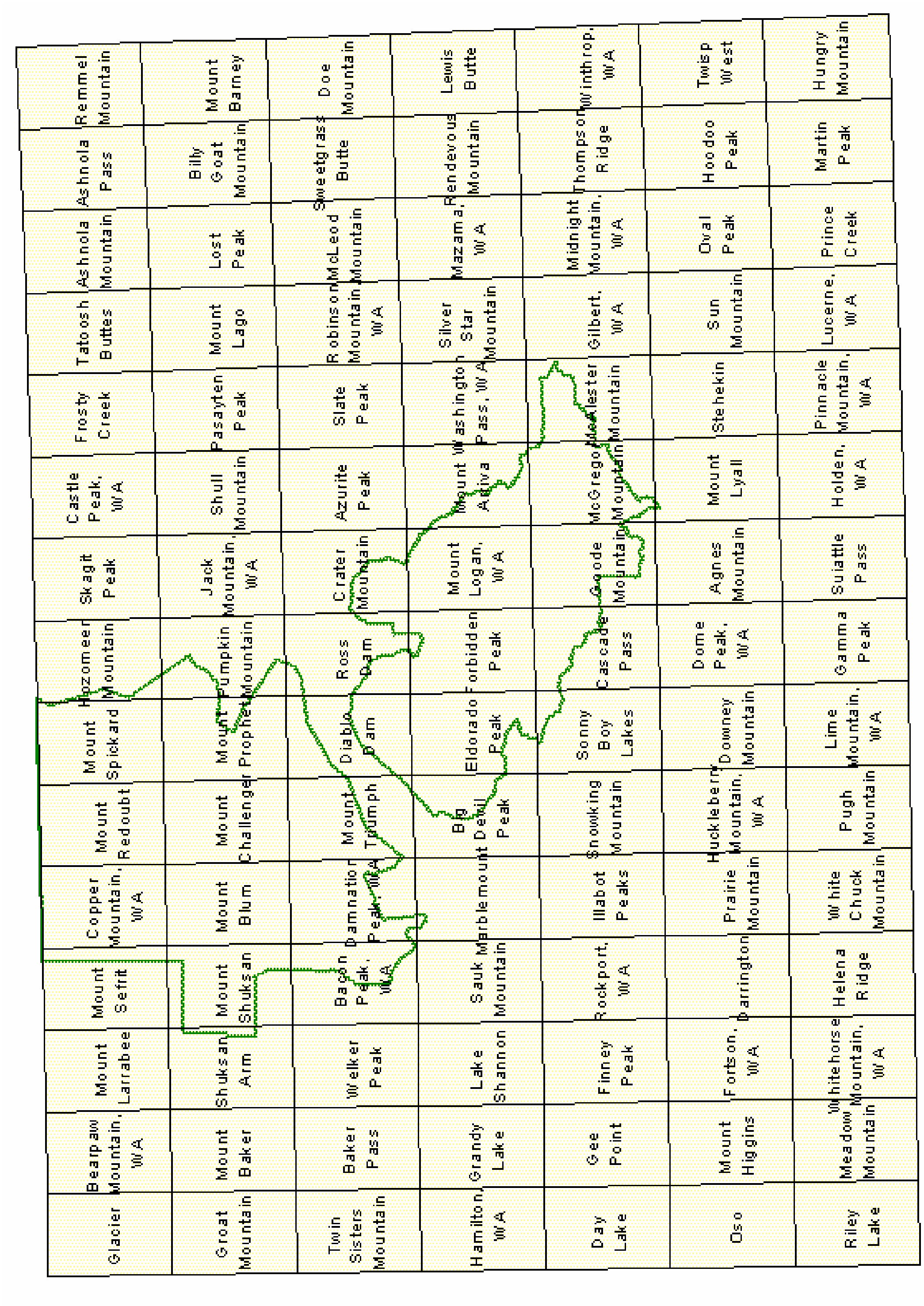
Tim Connors	Geologist	NPS, Geologic Resources Division
Craig Dalby	GIS Coordinator	NPS, Pacific West Region
Marsha Davis	Geologist	NPS, Pacific West Region
John Graham	Geologist	Colorado State University cooperator
Joe Gregson	Physical Scientist	NPS, Natural Resources Information Division
Ralph Haugerud	Geologist	USGS, Seattle
Bruce Heise	Geologist	NPS, Geologic Resources Division
Penny Latham	I&M Coord.	NPS, Pacific West Region
Bonnie Murchey	Geologist	USGS, Western Region, Menlo Park
Dave Norman	Geologist	WA DNR, Department of Geology and Earth Resources
Pat Pringle	Geologist	WA DNR, Department of Geology and Earth Resources
Jon Riedel	Geologist	North Cascades National Park Service Complex
Ron Teissiere	State Geologist	WA DNR, Department of Geology and Earth Resources

List of Preparers

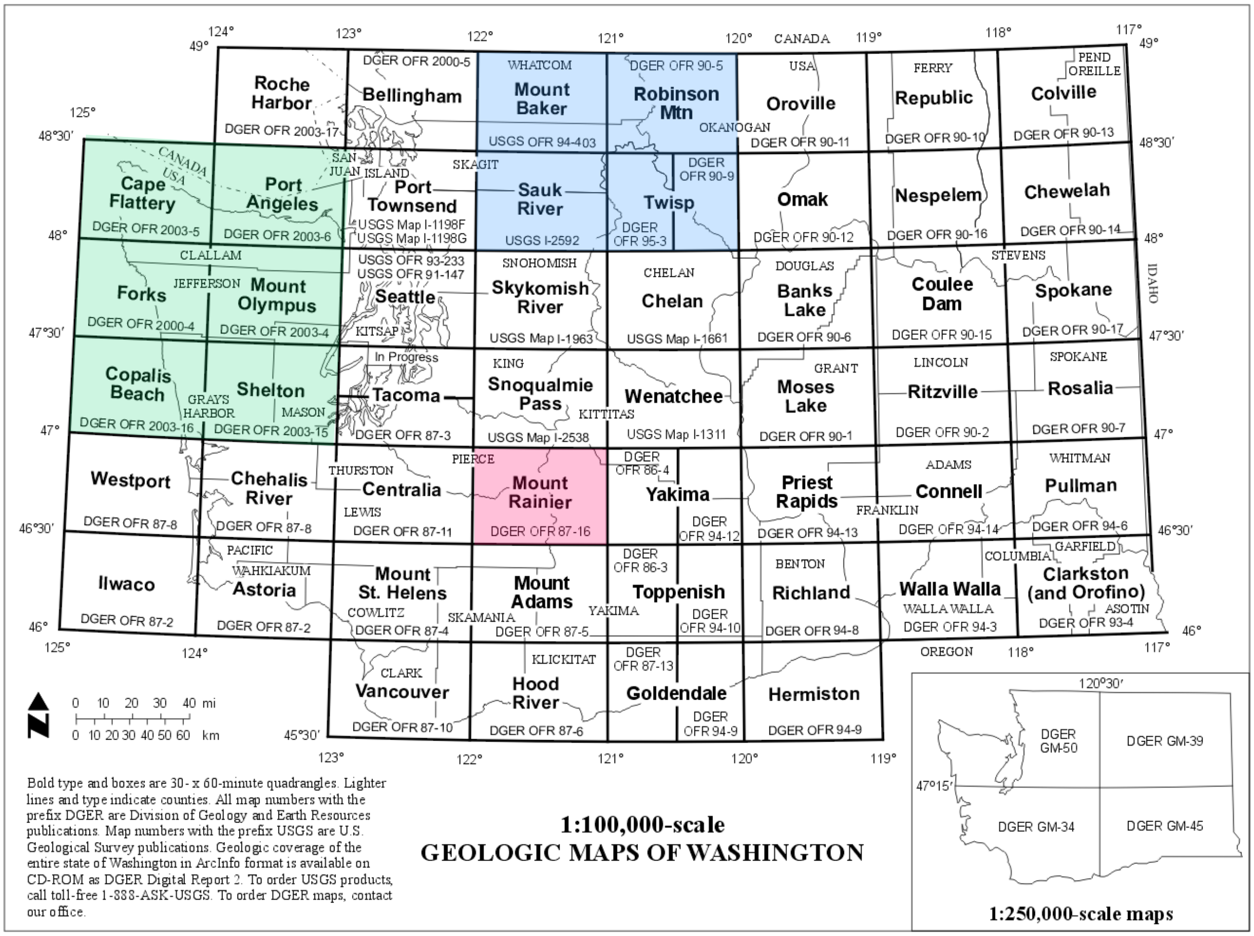
Marsha Davis, Geologist, Pacific West Regional Office, Seattle
Jon Riedel, Geologist, North Cascades NPS Complex, Marblemount, WA
Bruce Heise, Geologist, WASO Geologic Resources Division, Denver, CO
Tim Connors, Geologist, WASO Geologic Resources Division, Denver, CO

Appendix A

NOCA 7.5 minute quadrangles of interest (105)



30 x 60 minute quadrangle (1:100,000 scale) geologic map index of Washington State



Olympic National Park | North Cascades NPS Complex | Mount Rainier National Park

Geologic map of the **Mount Baker** 30- by 60- minute quadrangle, Washington, USGS I-Map 2660, 1:100,000 scale. Tabor, R. W.; Haugerud, R. A.; Hildreth, W.; Brown, E. H., 2003.

Geologic map of the **Sauk River** 30- by 60-minute quadrangle, Washington, USGS I-Map 2592, 1:100,000 scale. Tabor, R. W.; Booth, D. B.; Vance, J. A.; Ford, A. B., 2002,

Geologic map of the **Robinson Mountain** 30- by 60-minute quadrangle, Washington, USGS I-Map XXXX, 1:100,000 scale. Tabor, R. W., et al., (in press)

Geologic map of the **Twisp** 30- by 60-minute quadrangle, Washington, USGS I-Map XXXX, 1:100,000 scale. Tabor, R. W., et al., (in press)

Appendix B

Published geologic map citations for northern Washington

(Citations in bold selected for Baseline Inventory of bedrock geology, but not surficial geology)

Full Citation	GRE Gmap id	Scoped	Digitize for Baseline Inventory
Klungland, Michael W.; McArthur, Michael, 1989, Soil survey of Skagit County area, Washington, US Department of Agriculture, unknown, 1:24000 scale	2123	yes	no
Minard, J.P., 1985, Geologic map of the Lake Stevens quadrangle, Snohomish County, Washington, USGS, MF-1742, 1:24000 scale	3178	yes	no
Heller, P. L., 1979, Maps showing landslides and relative slope stability of Quaternary deposits of the lower Skagit and Baker valleys, North Cascades, Washington, USGS, OF-79-0963, 1:62500 scale	2130	yes	no
Misch, Peter, 1979, Geologic map of the Marblemount quadrangle, Washington, Washington Division of Geology and Earth Resources, GM-23, 1:48000 scale	3116	yes	no
Yount, J. C.; Marcus, K. L.; Mozely, P. S., 1980, Radiocarbon-dated localities from the Puget Lowland, Washington, USGS, OF-80-0780, 1:250000 scale	3228	yes	no
Haugerud, Ralph A., 1979, Map of the bedrock geology of the North Cascades and surrounding areas, Western Washington University, unknown, 1:250000 scale	3227	yes	no
Miller, Robert D.; Safioles, Sally A.; Pessl, Fred, Jr., 1985, Map showing relative slope stability in the Port Townsend 30' by 60' Quadrangle, Puget Sound region, Washington, USGS, I-1198-C, 1:100000 scale	2141	yes	no
Hyde, J. H.; Crandell, D. R, 1978, Postglacial volcanic deposits at Mount Baker, Washington, and potential hazards from future eruptions, USGS, P 1022-C, 1:250000 scale	2155	yes	no
Dragovich, J.D., Norman, D.K., Haugerud, R.A., and Miller, R.B., 1997, Geologic map and bedrock history of the Gilbert 7.5-minute quadrangle, Chelan and Okanogan Counties, Washington; Geochronology, by W. C. McClelland and P. Renne, Washington Division of	3174	yes	no
Dethier, D. P.; Whetten, J. T., 1980, Preliminary geologic map of the Clear Lake SW Quadrangle, Skagit and Snohomish counties, Washington, USGS, OF-80-0825, 1:24000 scale	3173	yes	no
Goldin, Alan, 1992, Soil survey of Whatcom county area, Washington, Washington Department of Natural Resources, unknown, 1:24000 scale	3172	yes	no
Frizzell, V.A., 1979, Point count data and sample locations for selected samples from Paleogene nonmarine sandstones, Washington, USGS, OF-79-293, 1:250000 scale	2153	yes	no
Gardner, J.N and Wright, T.L., 1979, Reconnaissance geologic map of the Columbia River Basalt Group in eastern Washington and northern Idaho, USGS, OF-79-1363, 1:250000 scale	2051	yes	no
Stoffel, K.L., Joseph, N.L., Waggoner, S.Z., Gulick, C.W., Korosec, M.A., and Bunning, B.B., 1991, Geologic map of Washington- northeast quadrant, Washington Division of Geology and Earth Resources, GM-39, 1:250000 scale	2057	yes	no
Whetten, J.T., Carroll, P.I., Gower, H.D., Brown, E.H., and Pessl, Fred, 1988, Bedrock geologic map of the Port Townsend 30- by 60-minute quadrangle, Puget Sound region, Washington, USGS, I-1198-G, 1:100000 scale	3068	yes	no
Cater, F.W. and Crowder, D.F., 1967, Geologic map of the Holden quadrangle, Snohomish and Chelan Counties, Washington, USGS, GQ-646, 1:62500 scale	3189	yes	no
Todd, V.R., 1995, Geology of part of the Mazawa quadrangle, Okanogan County, Washington, USGS, OF-95-523, 1:62500 scale	3197	yes	no
Todd, V.R., 1995, Geologic map of the Doe Mountain 15' quadrangle, Okanogan County, Washington, USGS, MF-2306, 1:62500 scale	3196	yes	no
Tabor, R.W. and Crowder, D.F., 1969, On batholiths and volcanoes - intrusion and eruption of Late Cenozoic magmas in the Glacier Peak area, North Cascades, Washington, USGS, PP 604, 1:62500 scale	3195	yes	no
Minard, J.P., 1980, Distribution and description of the geologic units in the Arlington East quadrangle, Washington, USGS, OF-80-460, 1:24000 scale	3177	yes	no
Barksdale, J.D., 1975, Geology of the Methow Valley, Okanogan County, Washington, Washington Division of Geology and Earth Resources, Bulletin 68, 1:125000 scale	2150	yes	no
Vance, J. A.; Dungan, M. A.; Blanchard, D. P.; Rhodes, J. M., 1980, Tectonic setting and trace element geochemistry of Mesozoic ophiolitic rocks in western Washington, University of Washington, Part I, 1:62500 scale	3194	yes	no
Moen, W.S., 1962, Geology and mineral deposits of the north half of the Van Zandt quadrangle, Whatcom County, Washington, Washington Division of Mines and Geology, Bulletin 50, 1:62500 scale	3193	yes	no
Cater, F.W. and Crowder, D.F., 1956, Geologic map of the Holden quadrangle, Washington, USGS, OF-56-24, 1:31680 scale	3182	yes	no
Easterbrook, D. J., 1976, Map showing slope stability in western Whatcom County, Washington, USGS, I-854-C, 1:62500 scale	3191	yes	no
, 1979, Aeromagnetic map of the Cascade Pass area, Washington, USGS, OF-79-1645, 1:62500 scale	3200	yes	no
Cater, F.W. and Wright, T.L., 1967, Geologic map of the Lucerne quadrangle, Chelan County,	3190	yes	no

Full Citation	GRE Gmap id	Scoped	Digitize for Baseline Inventory
Washington, USGS, GQ-647, 1:62500 scale			
Church, S.E.; Tabor, R. W.; Johnson, F. L., 1983, Mineral resource potential map of the Glacier Peak Roadless Area, Snohomish County, Washington, USGS, MF-1380-C, 1:50000 scale	3188	yes	no
Armstrong, J.E.; Corrigan, P., 1980, Surficial geology, Chilliwack (west half), west of sixth meridian, British Columbia, Geological Survey of Canada, 1487A, 1:50000 scale	3187	yes	no
Kovachic, H., 1980, Surficial geology, Mission, British Columbia, Geological Survey of Canada, 1485A, 1:50000 scale	3186	yes	no
Tabor, R.W., Haugerud, R.A., Booth, D.B., and Brown, E.H., 1994, Preliminary geologic map of the Mount Baker 30-by-60-minute quadrangle, Washington, USGS, OF-94-403, 1:100000 scale	3119	yes	no
Tabor, R. W.; Haugerud, R. A.; Hildreth, W.; Brown, E. H., 2003, Geologic map of the Mount Baker 30- by 60- minute quadrangle, Washington, USGS I-Map 2660, 1:100,000 scale.		**yes**	**yes**
McGroder, Michael F.; Garver, John L.; Mallory, V. Standish, 1990, Bedrock geologic map, biostratigraphy and structure sections of the Methow Basin, Washington and British Columbia, Washington Division of Geology and Earth Resources, OFR 90-19, 1:50000 sc	3185	yes	no
Easterbrook, D.J., 1976, Geologic map of western Whatcom County, Washington, USGS, I-854-B, 1:62500 scale	3117	yes	no
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Frederick, J. E., 1980, Map showing natural land slopes, Port Townsend Quadrangle, Puget Sound region, Washington, USGS, I-1198-A, 1:100000 scale	2143	yes	no
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Keuler, R. F., 1982, Map showing some potential effects of petroleum spills on shorelines of the Port Townsend Quadrangle, central Puget Sound region, Washington, USGS, MF-1238, 1:100000 scale	2140	yes	no
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Ford, A. B., 1983, Map of bedrock geologic data sites, Clacier Peak Wilderness Study, Chelan, Skagit, and Snohomish counties, Washington, USGS, OF-83-0454, 1:100000 scale	3210	yes	no
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